# UNDERSTORY VEGETATION OF THORN-SCRUB WOODLANDS AT THE CHAPARRAL WILDLIFE MANAGEMENT AREA, DIMMIT AND LASALLE COUNTIES, TEXAS

**John E. Ebinger**
Emeritus Professor of Botany, Eastern Illinois University, Charleston, Illinois, 61920 (jeebinger@eiu.edu),

**David S. Seigler**
Department of Plant Biology, University of Illinois, Urbana, Illinois 61801 (seigler@life.uiuc.edu),

**Loy R. Phillippe**
Illinois Natural History Survey, 816 South Oak Street, Champaign, Illinois 61820 (rickp@inhs.uiuc.edu)

ABSTRACT

The South Texas Plains was originally open savanna dominated by *Prosopis glandulosa* (honey mesquite) along with scattered brushy regions, whereas the ground layer was dominated by short and mid-grasses and forbs. This open savanna has changed to thorn-scrub woodland within the last 150 years, apparently due to anthropogenic forces, including overgrazing and reduced fire frequency. We undertook this study to determine the structure and composition of these thorn-scrub woodlands at the Chaparral Wildlife Management Area (CWMA), Dimmit and LaSalle Counties, Texas, in the northern half of the South Texas Plains. Within this 6,150 ha site the spring and fall ground layer vegetation under various thorn-scrub woodlands and adjacent aerated (roll-chopped) sites were surveyed. Species diversity was relatively high with 318 species of vascular plants encountered at the CWMA. Fern, "fern-allies", and gymnosperms were represented by 4 taxa in 3 families. Of the remaining taxa, 65 were monocots in 8 families, and 249 were dicots in 63 families. Non-native (exotic) species accounted for 17 taxa, about 5% of the species collected. The Poaceae was the most common family with 49 species, Asteraceae was second with 46 species, and the Fabaceae was represented by 32 species. No state endangered or threatened species were encountered. In both the fall and spring

surveys grasses dominated, introduced *Pennisetum ciliaris* (buffelgrass) being very important, followed by *Urochloa ciliatissima* (fringed signalgrass), *Chloris cucullata* (hooded windmill grass), *Bouteloua hirsuta* (hairy grama), *Eragrostis lehmanniana* (Lehmann's lovegrass), *Aristida purpurea* (purple three-awn), and *Digitaria cognata* (fall witchgrass). Forbs were more common during the spring survey with 98 species found in plots. *Phytologia 93(1): 13-42 (April 1, 2011).*

**KEY WORDS:** ground-layer vegetation, importance values, South Texas Plains, species list, spring and fall surveys, thorn-scrub communities.

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The South Texas Plains once supported an open savanna with a ground layer of short and mid-grasses and forbs in which woody vegetation was dominated by *Prosopis glandulosa* (honey mesquite), along with other shrubs and trees. This region also contained a mosaic of rocky, broken uplands that were dominated by relatively dense brushy vegetation. This open savanna has changed to thorn-scrub woodland within the last 150 years, apparently due to anthropogenic forces (Correll and Johnston 1970; Van Auken 2000; Ruthven 2001). Most of these changes involve dramatic increases in native woody taxa that were historically present in low densities (Johnston 1963; Archer et al. 1988; Archer 1989). Along with this change in shrub and tree density there has been a corresponding change in ground layer species. Major shifts in the abundance of herbaceous species were probably the result of increased shading that caused a decrease in prairie species and a corresponding increase in species that were more shade-tolerant, less fire-tolerant, and more tolerant of moisture extremes.

Anthropogenic forces, particularly increased grazing pressure by domestic livestock, fire suppression, and the introduction of exotic species (particularly grasses) have reduced the abundance of native species. These changes resulted in the destruction of the extensive short and mid-grass prairie matrix (Archer et al. 1988; Ruthven et al. 2000; Ruthven 2001). *Prosopis glandulosa* was the pioneer woody species involved in this transition to thorn-scrub woodland, and is currently the common dominant throughout the southwestern United States and adjacent Mexico (Ruthven 2001). Species in two genera of

well-armed legumes (*Senegalia* and *Vachellia*) are also major components of these thorn-scrub woodlands. These two genera are segregates of the genus *Acacia* (*sensu lato*) and are common throughout the arid and semi-arid environments of the South Texas Plains (Isely 1998).

Thorn-scrub woodlands are common at the Chaparral Wildlife Management Area (CWMA). Within this community type the importance and distribution of the associated ground layer species is determined by various biotic and abiotic factors, such as climate, moisture, edaphic conditions, present and past grazing pressures, and fire. The objective of this study was to examine the structure and composition of the ground layer vegetation of the thorn-scrub woodland and adjacent disturbed sites to understand better the importance, distribution, and habitat preferences of these associated ground layer species.

## STUDY AREA

All study sites were at Chaparral Wildlife Management Area (CWMA), Dimmit and LaSalle Counties, Texas (28°20'N, 99°25'W). The CWMA is in the northern half of the South Texas Plains ecological region (Correll and Johnston 1970, Diamond et al. 1987, Ruthven et al. 2000, Ruthven 2001). Located 12 km west of Artesia Wells, the CWMA is deer-proof fenced and about 6,150 ha in size. Purchased in 1969 by the Texas Parks and Wildlife Department, it serves as a research and demonstration area. Domestic livestock have grazed the CWMA since the 18th century (Lehmann 1969). The CWMA utilizes a high intensity, low frequency rotational grazing system with stocking rates of one Animal Unit per 12 ha (Ruthven 2001). Most of the CWMA was chained in 1948 (Ruthven, personal communication). Chaining involves the use of two large tractors with a heavy linked chain connected at each end to each of the tractors. The chain is pulled across the ground, disrupting and pulling out much of the woody vegetation (Lehmann 1984). The land around CWMA is rangeland, most holdings being large cattle ranches.

Hot summers and mild winters characterize the climate of CWMA; short-term droughts are common (Norwine and Bingham 1985). Average daily minimum winter (January) temperature is 5°C,

average daily maximum summer (July) temperature is 37°C, and growing season is 240 to 365 days. Average annual precipitation (1951 to 1978) is 550 mm (Stevens and Arriaga 1985; Cooper et al. 2008). Precipitation patterns are bimodal with peaks in late spring (May and June), and early fall (September and October). Topography is level to gently rolling with an average elevation of 175 m above mean sea level. The thin calcareous soils have low productivity and are dominated by Duval very fine, sandy loams, gently sloping and Duval loamy fine sands, 0 to 5% slope (Gabriel et al. 1994; Stevens and Arriaga 1985). The soil surface layer is reddish brown, slightly acid, very friable, and 0 to 40 cm thick. Also present are shallow limestone ridges (calcareous rises) where soils are mildly to moderately alkaline and have a caliche layer near the surface.

## METHODS

**Floristic Composition:** CWMA was visited five times during the growing seasons of 2001 to 2005. During these visits voucher specimens from all habitat types throughout the CWMA were collected and deposited in the herbaria of the University of Illinois (ILL) and the Illinois Natural History Survey (ILLS), Champaign/Urbana, Illinois. The designation of exotic species follows Correll and Johnston (1970) and Nesom (2008). Nomenclature follows Jones et al. (1997), with the common names mostly from Correll and Johnston (1970).

**Ground Layer Sampling:** In early November of 2002 and again in late May of 2003 transects were located randomly along cardinal compass directions within each community of the four thorn-scrub communities studied. These sites were the same as those used to sample the woody vegetation of thorn-scrub communities that differed in their overstory composition (Seigler et al. 2007), and were originally selected based on the recommendation of CWMA personnel who located sites where the vegetation was mature and least disturbed. All were near level uplands with minimal disturbance, other than grazing. At these four sites (study sites 1A, 2A, 3A, 4A) a single line transect 50 m long was randomly established near the center of the long axis of each community. Adjacent to these four original study sites, CWMA personnel had previously aerated 2 to 4 hectares, with a double/tandem drum aerator pulled by a D7 bulldozer. Presently, aeration is the preferred choice of wildlife managers to improved pastures in south

Texas. The process is similar to roll-chopping, but the blades along the chopper drum are toothed and set at an angle across the face of the large drum rather than a continuous blade running parallel to the face of the drum (Ruthven and Krakauer 2004). This aerated ground had been left undisturbed for about one year. In each of these successional sites (study sites 1B, 2B, 3B, 4B) a single line transect 50 m long was randomly established near the center of the long axis of each community. In all eight sites studied (four aerated and four not aerated) quadrats 1 $m^2$ in size were located alternately along each transect (n = 50 plots). A random numbers table was used to determine the distance (0 to 9 m) a quadrat was located from the transect line. Species cover was determined using the Daubenmire (1959) cover class system as modified by Bailey and Poulton (1968). The modified Daubenmire cover scale is as follows: class 1 = 0 to 1%; class 2 = >1 to 5%; class 3 = >5 to 25%; class 4 = >25 to 50%; class 5 = >50 to 75%; class 6 = >75 to 95%; class 7 = >95 to 100%. Only ground layer species rooted within the quadrat frame were recorded. Mean cover was determined for each taxon using the mid-point values for each cover class, while Importance Value (IV) was calculated by summing relative cover and relative frequency (total possible 200). Listed below are the eight study sites (Seigler et al. 2007) with the dominant overstory species encountered, these species Importance Values (possible 200), and the GPS coordinates.

Site 1A: *Senegalia greggii* (IV of 68.6), *Opuntia engelmannii* (IV of 28.5), *Vachellia rigidula* (IV of 27.5). 28°20'29"/99° 22'47"
Site 1B. Aerated site next to 1A. 28° 20'23"/99°22'50"
Site 2A: *Prosopis glandulosa* (IV of 89.0), *Opuntia engelmannii* (IV of 48.8), *Vachellia bravoensis* (IV of 25.9). 28°18'06'/99°21'40"
Site 2B: Aerated site next to 2A. 28°18'11"/99°21'41"
Site 3A: *Opuntia engelmannii* (IV of 56.0); *Prosopis glandulosa* (IV of 52.7); *Vachellia bravoensis* (IV of 27.3). 28°18'07"/99°21'31"
Site 3B: Aerated site next to 3A. 28°18'09"/99°21'28"
Site 4A: *Vachellia rigidula* (IV of 46.8); *Senegalia berlandieri* (IV of 44.3); *Opuntia engelmannii* (IV of 26.7). 28°18'55"/99°20'46"
Site 4B. Aerated site next to 4A. 28°18'57"/99°20'52"

The Sorensen Index of Similarity (ISs) was used to determine the degree of vegetation similarity between the sites surveyed throughout the ICCA (Mueller-Dombois and Ellenberg 1974). This

index utilizes binary data (presence/absence) to measure the similarity in species composition between study sites and is represented by the following equation: [ISs = 2C/A+B x 100], A equals the number of species in the first community, B equals the number of species in the second community, and C equals the number of species common between the two communities. Pairwise comparisons were made between each of the communities examined for both the November 2002 and the May 2003 surveys.

## RESULTS

Species diversity was relatively high with 318 species of vascular plants encountered at CWMA (Appendix I). Fern, "fern-allies", and gymnosperms were represented by 4 taxa in 3 families. Of the remaining taxa, 65 were monocots in 8 families, and 249 were dicots in 63 families. Non-native (exotic) species accounted for 17 taxa, about 5% of the species collected (Nesom 2008). As is typical of prairie and thorn-scrub vegetation, Poaceae was the most common family with 49 species, Asteraceae was second with 46 species, whereas Fabaceae was represented by 32 species. No state endangered or threatened species were encountered.

**Fall Survey:** Collectively, 72 species were encountered in the plots of the eight sites examined at CWMA during the fall survey (Table 1), based on the highest average importance value of each species (total IV of a species in all study sites). Grasses and grass-like species dominated, introduced *Pennisetum ciliaris* (buffelgrass) being an important component of five study sites, followed by *Urochloa ciliatissima* (fringed signalgrass), *Chloris cucullata* (hooded windmill grass), *Bouteloua hirsuta* (hairy grama), *Eragrostis lehmanniana* (Lehmann's lovegrass), *Aristida purpurea* (purple three-awn), *Cyperus retroflexus* (flatsedge), and *Digitaria cognata* (fall witchgrass) that were common in four to seven of the sites studied. Common forbs among the top 10 species included *Evolvulus alsinoides* (ojo de víbora) and *Croton glandulosus* (northern croton), with *Tiquilia canescens* (oreja de perro) being common only in Site 4A where it was the most important species with an IV of 83.1 (200 possible). Site 4A was located on a shallow limestone ridge where soils were moderately alkaline and most of the grass species found on the other study sites

were uncommon or absent. This site had a low ISs when compared to the other sites studied in the fall survey (Table 2).

Of the 72 taxa found in the plots examined, 19 taxa were recorded for only one of the eight sites examined (Table 1). Of these species, most were recorded in low number, occurring in only a few plots. Only in Site 4B did two species restricted to only one site have IVs greater than 2.5 [*Tridens muticus* (IV of 19.9) and *Sideroxylon celastrinum* (IV of 3.4)]. An additional 19 taxa were encountered in only two of the study sites. Over half of this group were common components of one study site, and only rarely encountered in another. Only two exotic species were found in the plots: *Eragrostis lehmanniana* and *Pennisetum ciliaris* (Table 1). Both species had relatively high IVs and are commonly planted for forage (Ruthven 2001, Lonard and Judd 2002).

**Spring Survey:** Ninety-eight species (excluding the grass taxa that are listed as a species group) were encountered in the plots of the eight sites examined at the CWMA during the spring survey (Table 3). Based on the importance value of each species (total IV of a species on all study sites) members of grass-like species dominated. As grasses were mostly dormant or vegetative, and the same species that we had encountered in the fall survey, we treated the grass taxa as a species group. Together these species usually accounted for more than one-quarter of the total IV in each of the study sites. Dominant forbs in most study sites were *Coreopsis nuecensis* (tick-seed), *Gamochaeta purpurea* (purple cudweed), *Aphanostephus riddellii* (Riddell's lazy daisy), *Oxalis dillenii* (yellow wood sorrel), *Plantago hookeriana* (tallow weed), and *Nothoscordum bivalve* (crow-poison), whereas *Oenothera grandis* (showy ragged evening primrose) and *Tiquilia canescens* (oreja de perro) were common only on the limestone ridge of Site 4A. As in the fall survey, Site 4A had a low ISs when compared to the other sites studied (Table 4).

Of the 98 taxa found in the plots examined, 32 were recorded for only one of the eight sites examined (Table 3). Of these species, most were recorded in low numbers, occurring in only a few plots. Only in Sites 4A and 4B was a species restricted to only one site with an IV greater than 2.5 [*Houstonia croftiae* (IV of 4.4) and *Draba*

*cuneifolia* (IV of 3.9)]. An additional 14 taxa were encountered in only two of the study sites. Over half of this group were common components of one study site, and only rarely encountered in one other. Except for the two grasses reported in the fall survey no other exotic species were encountered in the plots.

## DISCUSSION

The thorn-scrub vegetation of CWMA and surrounding area is representative of that associated with the South Texas Plains (South Texas Brush Country or Tamaulipan Brushlands) (Johnston 1963, Correll and Johnston 1970). Throughout most of this rangeland, *Prosopis glandulosa* is the dominant woody species, with about 10 to 15 other woody or large succulent, mostly thorny species, varying in abundance and composition. At CWMA, *P. glandulosa* is usually the dominant woody species, but, on some areas, other woody legumes are dominant or co-dominant, particularly various species of *Senegalia* and *Vachellia* (*Acacia s.l.*). This woodland community, where dominant trees are more than 3 m tall and formed a 26-60 percent canopy, would be equivalent to the Deciduous Woodland, Mesquite-Huisache Series (*Prosopis glandulosa-Vachellia farnesiana*) of Diamond et al. (1987) with other thorny legume species replacing *V. farnesiana.*

The ground layer vegetation at the study sites at CWMA was mostly similar, many of the species encountered being found on most of the eight study sites. In particular, the associated aerated communities for each of the four thorn-scrub communities studied consistently had ISs between 56.6 and 74.1 for the fall survey (Tables 2), and 65.5 and 83.5 for the spring survey (Table 4). These aerated communities were cleared two years previous to the study but many of the ground layer species were present, many with similar IVs. The few exotic species present (*Pennisetum ciliaris, Eragrostis lehmanniana*) mostly did not show much of an increase in frequency, cover, or IV on most aerated communities. In contrast, *Pennisetum ciliaris,* the dominant exotic grass found on some of the study sites did increase in IV from 50.6 to 90.6 on Site 3 (Table 1). Site 3 was slightly drier with *Opuntia engelmannii* the dominant overstory species, which may have accounted for this increase due to lower grazing pressure.

On all study sites, the soil texture was relatively uniform, being sandy loams with 61 to 75% sand, 12 to 20% silt, and 11 to 19% clay, and none were saline. Soils of Sites 1, 2, and 3 were mildly to strongly acidic whereas soils at Site 4, in contrast, were from a calcareous ridge and were mildly too moderately alkaline. Although all sites had relatively high levels of available calcium, site 4, was significantly higher ($P < 0.0001$) (Seigler et al. 2007). These differences in soil pH were probably responsible for some differences recorded in ground layer species distribution at CWMA.

*The Senegalia greggii/Opuntia engelmannii* community had a restricted distribution at CWMA (Site 1) being common on dry sandy ridges. At this location *S. greggii* was the dominant member of the community, accounting for one-third of the total IV. This community, which is probably maintained by fire, grazing, and sandy soil, is classified as the Catclaw Acacia Series, Deciduous Scrubland (*Senegalia greggii*). The woody vegetation at this site was short with only a few individuals being more than 2 m tall while the canopy cover was estimated at 25 to 30 percent (Seigler et al. 2007). Both Site 2 and 3 are similar to the Catclaw Acacia Series, being classified as the Deciduous Woodland, Mesquite-Huisache Series (*Prosopis glandulosa-Vachellia farnesiana*) of Diamond et al. (1987) with *Opuntia engelmannii* being common and *Vachellia bravoensis* replacing *V. farnesiana*. The ground layer vegetation in both the spring and fall surveys of the Catclaw Acacia Series (Site 1) and the Mesquite-Huisache Series (Sites 2 and 3) were similar in both the spring and fall surveys with the ISs always 48 or above (Tables 2 and 4).

*Vachellia rigidula* and *Senegalia berlandieri* dominated limestone ridges (calcareous rises) at CWMA (Site 4). This community was dominated by shrubs or small trees 0.5 to 3 m tall that formed 26 percent of more of the total canopy and was equivalent to the Deciduous Shrubland, Blackbrush Series (*Vachellia rigidula*) of Diamond et al. (1987). Though many of the ground layer species encountered were associated with all of the study sites, some of the species associated with the limestone ridges were found only associated with Sites 4A and B, or were much more common on those sites. Ground layer species mostly associated with these limestone ridges included *Aristida purpurea, Astragalus nuttalianus, Bouteloua trifida,*

*Dyssodia pentachaeta, Justicia pilosella, Lepidium lasiocarpum, Menodora heterophylla, Nama jamaicense, Nothoscorum bivalve, Oenothera grandis, Spermolepis echinata, Tiquilia canescens,* and *Tridens muticus* (Table 1 and 3). Of these, *Aristida purpurea* and *Tridens muticus* were only found at aerated Site 4B of the limestone ridge. The ISs for Site 4A during the fall survey was 17.0 to 30.8, less than half of the ISs recorded for the other sites (Table 2).

In a study on the CWMA involving species distribution under *Prosopis glandulosa* many of the common species found were the same we reported as common in the present study. Ruthven's (2001) list included *Bouteloua hirsuta, Chloris cucullata, Digitaria cognata, Eragrostis lehmanniana, Eragrostis secundiflora, Panicum capillarioides, Paspalum setaceum, Urochloa ciliatissima,* and *Evolvulus alsinoides* (Table 1). In a later study involving the species abundance and distribution after aeration, Ruthven and Krakauer (2004) found that aeration maintained woody species diversity, that the woody cover increased very rapidly after aeration, and that grass and forb richness, diversity, and evenness did not differ significantly among treatments.

The reasons for the continued prevalence of thorn-scrub woodland communities along with their associated ground-layer species are not entirely clear, but overgrazing and fire suppression were probably the primary causes (Van Auken 2000). At the time of European settlement much of the South Texas Plains was covered with open savanna and a dense groundcover of grasses and forbs. Many of the herbaceous species of this savanna were associated with the short and mid-grass prairie of central Texas. At that time wildfires were undoubtedly frequent and of sufficient intensity to prevent or delay encroachment by native woody species. However, overgrazing by livestock reduced the fuel load. This associated with fire suppression allowed for a significant decrease in fire frequency creating ideal conditions for the rapid explosion of native invaders. With the development of thorn-scrub communities, the resulting canopy closure, an increased water loss due to more rapid run-off resulted in a decrease of the integrity of the prairie. This decrease in the prairie community structure resulted in a corresponding loss in biodiversity.

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Table 1. Importance value (IV) of the ground layer species encountered in a fall survey (2002) of thorn-scrub vegetation (1A, 2A, 3A, 4A) and adjacent aerated sites (1B, 2B, 3B, 4B) at the Chaparral Wildlife Management Area, Dimmit and LaSalle Counties, Texas. Also listed is the cover of bare ground and litter, and the total number of species in the plots of each site. Only species with and IV of $\pm$ 4.5 for a site are included. * non-native species.

| Species / Sites | 1A | 1B | 2A | 2B | 3A | 3B | 4A | 4B |
|---|---|---|---|---|---|---|---|---|
| **Pennisetum ciliaris* | -- | -- | 25.6 | 33.9 | 50.6 | 90.6 | -- | 23.2 |
| *Urochloa ciliatissima* | 18.7 | 23.6 | 33.6 | 30.6 | 28.9 | 10.8 | -- | -- |
| *Evolvulus alsinoides* | 20.3 | 19.7 | 20.1 | 23.1 | 21.8 | 15.2 | 1.7 | 2.1 |
| *Croton glandulosus* | 12.9 | 12.2 | 29.9 | 44.9 | 10.1 | 2.6 | -- | -- |
| *Chloris cucullata* | 0.9 | 6.6 | 22.3 | 14.0 | 9.4 | 21.5 | -- | 12.4 |
| *Tiquilia canescens* | -- | -- | -- | -- | -- | -- | 83.1 | 3.0 |
| *Bouteloua hirsuta* | 38.3 | 24.5 | 7.8 | 10.2 | -- | -- | -- | -- |
| **Eragrostis lehmanniana* | 20.6 | 30.4 | 2.5 | 1.2 | 10.3 | 2.2 | 4.4 | 1.1 |
| *Aristida purpurea* | 5.1 | 3.8 | 4.8 | -- | 6.1 | 1.0 | -- | 46.4 |
| *Cyperus retroflexus* | 6.7 | 7.1 | 7.2 | 8.1 | 8.0 | 1.3 | -- | 7.7 |
| *Digitaria cognata* | 2.2 | 10.4 | 2.9 | 4.6 | 4.0 | 1.8 | -- | 17.4 |

Table 1 (continued).

| Species / Sites | 1A | 1B | 2A | 2B | 3A | 3B | 4A | 4B |
|---|---|---|---|---|---|---|---|---|
| *Palafoxia texana* | 5.1 | 24.7 | 2.1 | 1.6 | 3.0 | 0.6 | -- | 0.7 |
| *Bouteloua trifida* | -- | -- | -- | -- | -- | -- | 20.7 | 7.0 |
| *Diodia teres* | 29.8 | 2.4 | -- | -- | -- | -- | -- | -- |
| *Dyssodia pentachaeta* | -- | 0.8 | -- | -- | -- | -- | 23.8 | 2.5 |
| *Nothoscordum bivalve* | -- | -- | -- | -- | 3.2 | -- | 20.8 | -- |
| *Sida abutifolia* | -- | 0.9 | 2.6 | 2.2 | 3.4 | 6.0 | 5.3 | 1.8 |
| *Paspalum setaceum* | 1.4 | -- | 6.8 | -- | 7.5 | 0.6 | -- | 3.8 |
| *Tridens muticus* | -- | -- | -- | -- | -- | -- | -- | 19.9 |
| *Eragrostis secundiflora* | 3.3 | 7.4 | 0.5 | -- | 3.6 | -- | 2.1 | 1.8 |
| *Setaria texana* | -- | -- | -- | 3.7 | -- | -- | 2.1 | 11.0 |
| *Panicum capillarioides* | -- | -- | 2.6 | -- | 1.1 | 10.7 | 1.7 | -- |
| *Setaria reverchonii* | 0.9 | 8.4 | 3.9 | -- | 1.7 | 0.7 | -- | -- |
| *Cenchrus spinifex* | 7.1 | 0.8 | 2.1 | 4.5 | 0.6 | -- | -- | -- |
| *Opuntia engelmannii* | -- | 1.0 | 5.5 | -- | 5.4 | 0.7 | -- | 2.5 |
| *Mollugo verticillata* | 0.9 | -- | 3.0 | 1.7 | 4.5 | 3.5 | -- | 0.6 |
| *Justicia pilosella* | -- | -- | -- | -- | -- | 1.0 | 8.0 | 2.3 |
| *Phyllanthus polygonoides* | 0.9 | -- | -- | -- | -- | 10.1 | -- | -- |
| *Eragrostis curtipedicillata* | -- | -- | 1.0 | -- | 1.1 | 2.2 | -- | 6.6 |
| *Eragrostis sessilispica* | 5.3 | -- | 1.6 | 3.8 | -- | -- | -- | -- |
| *Menodora heterophylla* | -- | -- | -- | -- | -- | -- | 9.5 | 1.1 |
| *Chamaecrista fasciculata* | 2.3 | 8.0 | -- | -- | -- | -- | -- | -- |
| *Dalea nana* | 6.3 | 0.8 | -- | -- | -- | -- | -- | -- |

Table 1 (continued).

| Species / Sites | 1A | 1B | 2A | 2B | 3A | 3B | 4A | 4B |
|---|---|---|---|---|---|---|---|---|
| *Ambrosia psilostachya* | -- | -- | -- | -- | 0.6 | 6.1 | -- | -- |
| Other species | 11.0 | 6.5 | 11.6 | 11.9 | 15.1 | 10.8 | 16.8 | 25.1 |
| Total | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| Bare ground/litter cover | 51.80 | 44.78 | 47.80 | 32.53 | 49.77 | 28.09 | 79.21 | 39.63 |
| Total species for each site | 27 | 27 | 30 | 23 | 32 | 27 | 20 | 36 |

Table 2. Sorensen Index of Similarity of the ground layer vegetation at the eight communities examined in a fall survey (2002) at the Chaparral Wildlife Management Area, Dimmitt and LaSalle Counties, Texas.

| Site | 1A | 1B | 2A | 2B | 3A | 3B | 4A |
|---|---|---|---|---|---|---|---|
| 1A | | | | | | | |
| 1B | 74.1 | | | | | | |
| 2A | 63.2 | 56.1 | | | | | |
| 2B | 52.0 | 48.0 | 56.6 | | | | |
| 3A | 61.0 | 57.6 | 77.4 | 58.2 | | | |
| 3B | 48.1 | 48.1 | 63.2 | 48.0 | 64.4 | | |
| 4A | 17.0 | 25.5 | 20.0 | 27.9 | 30.8 | 29.8 | |
| 4B | 34.9 | 38.1 | 45.5 | 47.5 | 47.1 | 50.8 | 57.1 |

Table 3. Importance value (IV) of the ground layer species encountered in a spring survey (2003) of thorn-scrub vegetation (1A, 2A, 3A, 4A) and adjacent aerated sites (1B, 2B, 3B, 4B) at the Chaparral Wildlife Management Area, Dimmit and LaSalle Counties, Texas. Also listed is the cover of bare ground and litter, and the total number of species in plots of each site. Only species with an IV of ± 4.5 for a site are included. * non-native species

| Species | 1A | 1B | 2A | 2B | 3A | 3B | 4A | 4B |
|---|---|---|---|---|---|---|---|---|
| Total grasses (living/dead) | 67.6 | 52.6 | 59.6 | 45.2 | 56.7 | 74.2 | 39.0 | 77.7 |
| *Coreopsis nuecensis* | 34.4 | 49.2 | 6.1 | 35.1 | 22.3 | 0.6 | -- | -- |
| *Gamochaeta purpurea* | -- | -- | 13.2 | 15.2 | 8.0 | 23.6 | -- | 4.3 |
| *Aphanostephus riddellii* | 5.7 | 8.2 | 5.6 | 8.9 | 6.2 | 0.5 | 16.5 | 9.8 |
| *Oxalis dillenii* | 0.6 | 2.9 | 13.1 | 8.0 | 9.0 | 13.9 | 1.1 | 10.8 |
| *Plantago hookeriana* | 9.6 | 7.7 | 11.5 | 8.1 | 13.1 | 1.8 | -- | 1.1 |
| *Oenothera grandis* | -- | -- | 0.2 | 1.1 | 1.0 | 0.3 | 26.9 | 11.8 |
| *Nothoscordum bivalve* | 6.7 | 5.5 | 3.8 | 1.9 | 4.8 | 0.2 | 7.1 | 0.2 |
| *Nuttallanthus tenanus* | -- | 1.5 | 4.7 | 9.2 | 5.6 | 7.9 | -- | 0.4 |
| *Evolvulus alsinoides* | 6.8 | 5.5 | 3.1 | 5.6 | 4.9 | 2.1 | -- | 0.2 |
| *Dyssodia tenuiloba* | 0.6 | 0.3 | 3.0 | 0.3 | 8.4 | 5.7 | 3.3 | 6.5 |
| *Cyperus retroflexus* | 6.0 | 4.6 | 5.4 | 2.3 | 5.6 | 2.2 | -- | 0.2 |
| *Tiquilia canescens* | -- | -- | -- | -- | -- | -- | 25.7 | 0.6 |
| *Evax prolifera* | 3.3 | 1.9 | 5.1 | 0.9 | 1.0 | 0.9 | 6.8 | 5.3 |
| *Lesquerella argyraea* | 6.7 | 6.3 | 4.7 | 4.5 | 1.9 | 0.2 | -- | -- |
| *Ambrosia confertiflora* | -- | -- | 6.7 | -- | 4.3 | 11.1 | -- | -- |
| *Chamaesaracha coniodes* | 6.7 | 9.9 | -- | -- | -- | -- | 4.7 | 0.8 |
| *Palafoxia texana* | 1.3 | 9.2 | 1.9 | 1.4 | 6.3 | 1.1 | 0.1 | 0.4 |
| *Thelesperma filifolium* | 8.7 | 7.3 | 2.2 | 1.2 | 0.3 | 0.2 | -- | -- |

Table 3 (continued).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Gaura mckelveyae* | 0.6 | -- | 4.3 | 2.3 | 3.5 | 5.8 | 0.3 | 1.3 |
| *Lepidium virginicum* | -- | -- | 4.4 | 6.3 | 2.6 | 2.8 | -- | 1.5 |
| *Triodanis perfoliata* | -- | 0.5 | 7.2 | 4.8 | 3.2 | 1.4 | -- | -- |
| *Dalea nana* | 8.7 | 4.4 | 2.4 | -- | -- | 0.2 | 1.3 | -- |
| *Sida abutifolia* | 1.2 | 1.2 | 1.7 | 2.6 | 1.9 | 1.9 | 4.7 | 1.3 |
| *Plantago virginica* | -- | -- | 3.5 | 0.5 | 3.1 | 0.8 | 6.7 | 1.1 |
| *Parietaria pensylvanica* | -- | -- | 1.0 | 2.9 | 0.3 | 7.4 | -- | 4.0 |
| *Nama jamaicense* | -- | -- | -- | 0.5 | -- | -- | 2.3 | 12.4 |
| *Descurainia pinnata* | -- | -- | -- | 3.2 | -- | 8.5 | -- | 1.8 |
| *Astragalus nuttalianus* | 0.2 | 1.1 | 1.2 | 0.9 | 2.5 | -- | 4.6 | 2.0 |
| *Lepidium lasiocarpum* | 0.2 | -- | -- | -- | -- | -- | 5.9 | 5.9 |
| *Talinum parviflorum* | 4.7 | 1.4 | 2.4 | 0.3 | 2.1 | 0.7 | -- | -- |
| *Spermolepis echinata* | -- | -- | -- | -- | -- | -- | 7.1 | 4.1 |
| *Euphorbia micromera* | 1.0 | 0.2 | 1.3 | 0.2 | 1.3 | -- | 5.8 | 1.1 |
| *Linum imbricatum* | 3.9 | 4.9 | 1.3 | 0.2 | 0.6 | -- | -- | -- |
| *Gymnosperma glutinosum* | -- | -- | -- | -- | -- | -- | 0.2 | 9.5 |
| *Menodora heterophylla* | -- | -- | -- | -- | -- | -- | 5.8 | 1.0 |
| Other species | 14.8 | 13.7 | 19.4 | 26.4 | 19.5 | 24.0 | 24.1 | 22.9 |
| Total | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| Bare ground/litter | 33.1 | 17.0 | 21.2 | 8.5 | 25.4 | 6.8 | 29.3 | 12.5 |
| Total species for each site | 35 | 39 | 44 | 47 | 42 | 43 | 39 | 53 |

Table 4. Sorensen Index of Similarity of the ground layer vegetation at eight communities examined in a spring survey (2003) at the Chaparral Wildlife Management Area, Dimmitt and LaSalle Counties, Texas.

| Site | 1A | 1B | 2A | 2B | 3A | 4B | 4A |
|---|---|---|---|---|---|---|---|
| 1A | | | | | | | |
| 1B | 75.7 | | | | | | |
| 2A | 58.2 | 65.1 | | | | | |
| 2B | 48.8 | 55.8 | 83.5 | | | | |
| 3A | 54.5 | 61.7 | 88.4 | 83.1 | | | |
| 3B | 46.2 | 53.7 | 75.9 | 77.8 | 75.3 | | |
| 4A | 40.5 | 43.6 | 43.4 | 41.9 | 44.4 | 39.0 | |
| 4B | 38.6 | 39.1 | 51.5 | 62.0 | 54.7 | 54.2 | 65.2 |

Appendix I. Vascular plant species at Chaparral Wildlife Management Area, Dimmit and LaSalle Counties, listed alphabetically by family under major plant groups. Collecting numbers after each name are those of D. S. Seigler, and deposited in the herbarium of the University of Illinois (ILL). Specimens by L.R.Phillippe (P before the number) are deposited in the Illinois Natural History Survey herbarium (ILLS). Nomenclature follows Jones et al. (1997). (*exotic species)

FERN AND FERN-ALLIES

**MARSILEACEAE**

*Marsilea vestita* Hooker & Greville; 15043, 15490

**PTERIDACEAE**

*Astrolepis cochisensis* (Goodding) Benham & Windham; 15642

*Cheilanthes alabamensis* (Buckley) Kunze; 15643

GYMNOSPERMS
**EPHEDRACEAE**
*Ephedra antisyphilitica* C.A. Meyer; 14911, 15505

MONOCOTS
**AGAVACEAE**
*Agave americana* L.; 15639
*Yucca constricta* Buckley; 15154
*Yucca treculeana* Carrière; 15463, 15683

**COMMELINACEAE**
*Commelina erecta* L.; 14868, 15601

**CYPERACEAE**
*Carex tetrastachya* Scheele; 15200, 15607
*Cyperus acuminatus* Torrey & Hooker; 15046
*Cyperus echinatus* (L.) A. Wood; 15045
*Cyperus retroflexus* Buckley; 15005, 15377
*Eleocharis palustris* (L.) Römer & Schultes; 15497
*Fimbristylis vahlii* (Lamark) Link; 15126
*Schoenoplectus saximontanus* (Fernald) Raynal; 15488

**LILIACEAE**
*Cooperia drummondii* Herb; 15103
*Nothoscordum bivalve* (L.) Britton; 15184

**NAJADACEAE**
*Najas guadalupensis* (Sprengel) Magnus; 15625

**POACEAE**
*Agrostis hyemalis* (Walter) B.S.P.; 15487
*Aristida purpurea* Nuttall var. *purpurea*; 15216, 15397
*Aristida purpurea* Nuttall var. *wrightii* (Nash) Allred; 14935
*Bothriochloa barbinodis* (Lagasca) Herter; 14937, 15349
*Bouteloua barbata* Lagasca; 15085
*Bouteloua hirsuta* Laqasca; 15108, 15415
*Bouteloua trifida* Thurber; 15388, 15519
**Bromus catharticus* Vahl; 15174
*Cenchrus spinifex* Cavanilles; 14944

*Chloris cucullata* Bischoff; 14918, 15083
**Cynodon dactylon* (L.) Persoon; 14963
**Dactyloctenium aegyptium* (L.) Beauvois; 15086
**Dichanthium annulatum* (Forsskäl) Stapf; 15034
*Digitaria californica* (Bentham) Henrard; 14936
*Digitaria ciliaris* (Retzius) Köler; 15074, 15208
*Digitaria cognata* (Schultes) Pilger; 15206, 15373
*Eragrostis curtipedicellata* Buckley; 14989, 15427
**Eragrostis lehmanniana* Nees; 15146, 15413
*Eragrostis pectinacea* (Michaux) Nees var. *miserrima* (Fournier) J. Reeder; 15572
*Eragrostis reptans* (Michaux) Nees; 15127
*Eragrostis secundiflora* Presl; 15082, 15414
*Eragrostis sessilispica* Buckley; 14971
*Heteropogon contortus* (L.) Beauvois; 14987, 15365
*Leptochloa dubia* (Kunth) Nees; 15366
*Nasselia leucotricha* (Trinius & Ruprecht) Pohl; 15655
**Panicum antidotale* Retzius; 15348
*Panicum capillarioides* Vasey; 15368, 15376
*Panicum hallii* Vasey var. *filipes* (Scribner) F.Waller; 15396, 15481
*Panicum hians* Elliott; 15048
*Panicum nodatum* Hitchcock & Chase; 15198
*Panicum oligosanthes* Schultes; 15375
*Panicum virgatum* L.; 15736
*Pappophorum bicolor* Fournier; 15390
*Pappophorum vaginatum* Buckley; 15205
*Paspalum lividum* Trinius; 15745
*Paspalum setaceum* Michaux; 14947, 15197
**Pennisetum ciliaris* (L.) Link; 14919, 15351
*Setaria firmula* (Hitchcock & Chase) Pilger; 15426
*Setaria leucopila* (Scribner & Merrill) K. Schumann; 15196, 15733
*Setaria macrostachya* Kunth; 15132, 15733
*Setaria pumila* (Poiret) Römer & Schultes; 15047
*Setaria reverchonii* (Vasey) Pilger; 14970
*Setaria texana* W. Emery; 15395
**Sorghum halapense* (L.) Persoon; 15011
*Sporobolus cryptandrus* (Torrey) A.Gray; 15369
*Trichloris pluriflora* Fournier; 14934, 15670
*Tridens eragrostoides* (Vasey & Scribner) Nash; 15199, 15389

*Tridens muticus* (Torrey) Nash; 14976, 15403
*Urochloa ciliatissima* (Buckley) Webster; 15360, 15416

**PONTEDERIACEAE**
*Heteranthera limosa* (Swartz) Willdenow; 15747

**POTAMOGETONACEAE**
*Potamogeton nodosus* Poiret; 15489

DICOTS
**ACANTHACEAE**
*Carlowrightia texana* Henrickson & Daniel; 15423
*Justicia pilosella* (Nees) Hilsenbeck; 14958, 15387
*Ruellia nudiflora* (A. Gray) Urban var. runyonii (Tharp & Barkley) B. L. Turner; 15201

**AMARANTHACEAE**
*Alternanthera caracasana* Kunth; 15750
*Amaranthus albus* L.; 15001, 15120
*Froelichia floridana* (Nuttall) Moquin; 14865, 14959
*Froelichia gracilis* (Hooker) Moquin; 15101, 15678
*Gossypianthes lanuginosus* (Poiret) Moquin; 15562
*Tidestromia lanuginosa* (Nuttall) Standley; 15121, 15372

**ANACARDIACEAE**
*Rhus microphylla* Engelmann; 15677

**APIACEAE**
*Bowlesia incana* Ruiz & Pavón; 15483
*Daucus pusillus* Michaux; 15159, 15604
*Spermolepis echinata* (DC.) Heller; 15167, 15615

**ARISTOLOCHIACEAE**
*Aristolochia erecta* L.; 15177, 15580, 15595

**ASCLEPIADACEAE**
*Asclepias emoryi* (Greene) Vail; 14962
*Cynanchum barbigerum* (Scheele) Shinners; 14902, 15420
*Cynanchum laeve* (Michaux) Persoon; 15744

*Cynanchum racemosum* (Jacquin) Jacquin var. *unifarium* (Scheele) Sundall; 15128
*Matelea gonocarpos* (Walter) Shinners; 15425
*Matelea parviflora* (Torrey) Woodson; 15004

**ASTERACEAE**
*Acourtia runcinata* (D. Don) B. L. Turner; 15641
*Amblyolepis setigera* DC.; 15568, 15623
*Ambrosia confertiflora* DC.; 14923, 15593
*Ambrosia psilostachya* DC.; 14977, 15092
*Aphanostephus riddellii* Torrey & Gray; 15540
*Aphanostephus ramosissimus* DC.; 15362
*Baccharis neglecta* Britton; 15624, 15734
*Berlandiera texana* DC.; 15651
**Calyptocarpus vialis* Lessing; 15089
*Centaurea americana* Nuttall; 15661
*Chloracantha spinosa* (Bentham) Neson; 15050
*Cirsium texanum* Buckley; 14972, 15496
*Conyza canadensis* (L.) Cronq. var. *glabrata* (Gray) Cronquist; 15006
*Coreopsis nuecensis* Heller; 15538
*Coreopsis tinctoria* Nuttall; 14893, 15565
*Dichaetophosa campestris* A. Gray; 15158, 15898
*Dyssodia pentachaeta* (DC.) Robinson; 15166, 15393
*Dyssodia tenuiloba* (DC.) Robinson; 14877, 15567
*Evax prolifera* DC.; 15178
*Florestina tripteris* DC.; 14898, 15370
*Gaillardia pulchella* Fougeroux; 14892, 15590
*Gamochaeta purpurea* (L.) Cabrera; 15051
*Gutierrezia texana* (DC.) Torr. & Gray var. *glutinosa* (Schauer) Lane; 14909
*Gymnosperma glutinosum* (Sprengel) Lessing; 14973
*Helenium linifolium* Rydberg; 14884
*Helianthus annuus* L.; 15743
*Helianthus debilis* Nuttall; 14864, 15742
*Heterotheca subaxillaris* (Lamark) Britton & Rusby; 15075
*Hymenopappus scabiosaeus* L'Heritier var. *corymbosus* (Torrey & Gray) B. L. Turner; 15645
*Krigia occidentalis* Nuttall; 15637
*Liatris mucronata* DC.; 14993, 15131

*Melampodium cinereum* DC.; 14879, 15535
*Palafoxia texana* DC.; 14897, 15170
*Parthenium confertum* A.Gray; 15384, 15516
*Pseudognaphalium obtusifolium* (L.) Hilliard & Burtt; 15647
*Pyrrhopappus carolinianus* (Walter) DC.; 15500
*Pyrrhopappus pauciflorus* (D. Don) DC.; 14956, 15611
*Ratibida columnifera* (Nuttall) Wooton & Standlely; 15009
*Senecio ampullaceus* Hooker; 15586
*Simsia calva* (Engelmann & Gray) A.Gray; 15023
**Sonchus aspera* (L.) Hill; 15168
*Thelesperma burridgeanum* (Regel, Körnicke & Rach) Blake; 14891
*Thelesperma filifolium* (W. Hooker) A.Gray; 15646a
*Verbesina encelioides* (Cavanilles) A.Gray; 14863
*Verbesina microptera* DC.; 15385
*Xanthisma texanum* DC.; 15371

**BORAGINACEAE**
*Cordia boissieri* A.DC.; 15095
*Cryptantha texana* (A. DC.) Greene; P35386
*Heliotropium procumbens* Miller; 15125, 15664
*Heliotropium texanum* I.M. Johnston; 15209, 15355, 15411
*Lappula occidentalis* (Watson) Greene; 15480, 15650
*Lithospermum incisum* Lehmann; 15189
*Tiquilia canescens* (DC.) Richardson; 14933

**BRASSICACEAE**
*Arabis petiolaris* (A.Gray) A.Gray; 15465
*Descurainia pinnata* (Walter) Britton; 15162, 15513
**Diplotaxis muralis* (L.) DC.; 15872
*Draba cuneifolia* Torrey & Gray; 15632, 15870
*Lepidium lasiocarpum* Torrey & Gray; 15190
*Lepidium virginicum* L.; 14926
*Lesquerella argyraea* (A.Gray) Watson; 14881, 15539
*Lesquerella lasiocarpa* (A.Gray) Watson; 15485, 15618
*Rorippa teres* (Michaux) Stuckey; 15493
**Sisymbrium irio* L.; 15175, P36371

**BUDDLEJACEAE**
*Polypremum procumbens* L.; 15740

**CACTACEAE**
*Ancistocactus scheeri* (Salm-Dyck) Britt. & Rose; 15156
*Echinocereus enneacanthus* Engelmann; 15119
*Opuntia engelmannii* Salm-Dyck; 15012
*Opuntia leptocaulis* DC.; 15024

**CALLITRICHACEAE**
*Callitriche terrestris* Rafinesque; 15869

**CAMPANULACEAE**
*Triodanis perfoliata* (L.) Niewland; 15550, 15648

**CAPPARACEAE**
*Koeberlinia spinosa* Zuccarini; 15113
*Polanisia dodecandra* (L.) DC. subsp. *riograndensis* Iltis; 14946

**CARYOPHYLLACEAE**
*Loeflingia squarrosa* Nuttall; 15557
*Silene antirrhina* L.; 15173, 15596
**Stellaria media* (L.) Villars; 15650

**CELASTRACEAE**
*Schaefferia cuneifolia* A.Gray; 14912, 15510

**CHENOPODIACEAE**
*Chenopodium berlandieri* Moquin; 14928, 15666

**CONVOLVULACEAE**
*Convolvulus equitans* Bentham; 14996, 15574
*Evolvulus alsinoides* (L.) L.; 14984, 15381
*Evolvulus sericeus* Swartz; 15556 15638
*Ipomoea cordatotriloba* Dennstaedt; 14955, 15424
**CUCURBITACEAE**
*Ibervillea lindheimeri* (A.Gray) Greene; 14983
*Ibervillea tenuisecta* (A.Gray) Small; 15118
**CUSCUTACEAE**
*Cuscuta gronovii* Willdenow; 14931, 14978

**EBENACEAE**
*Diospyros texana* Scheele; 14874, 15553

**EUPHORBIACEAE**
*Argythamnia neomexicana* Müller of Aargau; 15394, 15617
*Bernardia myricifolia* (Scheele) Watson; 15755, P36474
*Croton capitatus* Michaux; 14995, 15123
*Croton glandulosus* L.; 15042, 15357
*Croton lindheimerianus* Scheele; 14896
*Euphorbia micromera* P. Boissier; 14924, 15522
*Jatropa dioica* Cervantes; 14951, 15016
*Phyllanthus polygonoides* Sprengel; 14975

**FABACEAE**
*Acaciella angustissima* (Miller) Britton & Rose; 15007, 15741
*Aeschynomene indica* L.; 15746
*Astragalus nuttallianus* DC. var. *austrinus* (Small) Barneby; 15476
*Astragalus nuttallianus* DC. var. *nuttallianus*; 15619
*Chamaecrista fasciculata* (Michaux) Greene; 14895, 15093
*Dalea emarginata* (Torrey & Gray) Shinners; 14880, 15542
*Dalea nana* Torrey; 14980, 15406
*Dalea pogonathera* A.Gray; 14979, 15537
*Desmanthus virgatus* (L.) Willdenow; 15033, 15739
*Eysenhardtia texana* Scheele; 14953
*Indigofera miniata* Ortega; 15096
*Lupinus texensis* Hooker; 15180, 15585
**Medicago polymorpha* L.; 15171, 15649
**Melilotus indicus* (L.) Allioni; 15646b
*Mimosa latidens* (Small) B.L. Turner; 14887, 15183
*Neptunia pubescens* Bentham; 15036
*Parkinsonia aculeata* L.; 15044
*Parkinsonia texana* (A.Gray) Watson;14907
*Prosopis glandulosa* Torrey; 14929, 15134
*Senegalia berlandieri* (Bentham) Britton & Rose; 14905
*Senegalia x emoryana* (Bentham) Britton & Rose; 15401
*Senegalia greggii* (A.Gray) Britton & Rose; 14890
*Senegalia roemeriana* (Scheele) Britton & Rose; 14954
*Senna lindheimeriana* (Scheele) Irwin & Barneby; 14949
*Senna roemeriana* (Scheele) Irwin & Barneby;15620

*Tephrosia lindheimeri* A.Gray; 14894
*Vachellia bravoensis* (Isley) Seigler & Ebinger; 14889
*Vachellia farnesiana* (L.) Wight & Arnott; 14967
*Vachellia rigidula* (Bentham) Seigler & Ebinger; 14994
*Vachellia rigidula x schaffneri*; 15114
*Vicia ludoviciana* Nuttall; 15470, 15635
*Zornia bracteata* J. F. Gmelin; 14878, 15579

**FAGACEAE**
*Quercus virginiana* Miller; 15097

**FUMARIACEAE**
*Corydalis aurea* Willdenow var. *aurea*; 15554

**GENTIANACEAE**
Sabatia campestris Nuttall; 14986

**GERANIACEAE**
*Erodium texanum* A. Gray; 15520

**HYDROPHYLLACEAE**
*Nama hispidum* A.Gray; 14886, 15605
*Nama jamaicense* L.; 15495, 15633
*Nama stenocarpum* A.Gray; 15663, P35259
*Phacelia congesta* Hooker; 14966, 15501

**KRAMERIACEAE**
*Krameria lanceolata* Torrey; 14871, 15561

**LAMIACEAE**
*Monarda punctata* L.; 14888
*Salvia ballotiflora* Bentham; 15018, 15582
*Scutellaria drummondii* Bentham var. *drummondii*; 15502
*Stachys crenata* Rafinesque; 15494, 15662

**LINACEAE**
*Linum berlandieri* Hooker; 14908, 15546
*Linum imbricatum* (Rafinesque) Shinners; 14872, P35341

**MALVACEAE**
*Abutilon fruticosum* Guillemin & Perrottel; 15399
*Abutilon wrightii* A.Gray; 15606
*Herissantia crispa* (L.) Brizicky; 15419, 15428
*Malvastrum coromandelianum* (L.) Garcke; 15203
*Rhynchosida physocalyx* (A.Gray) Fryxell; 15603, 15610
*Sida abutifolia* Miller; 14938, 15398
*Sida ciliaris* L.; 15738a
*Sida lindheimeri* Engelmann & A.Gray; 15410
*Sida tragiifolia* A.Gray; 15211, 15674
*Sidastrum paniculatum* (L.) Fryxell; 15409
*Sphaeralcea pedatifida* (A.Gray) A.Gray; 14915, 15511

**MOLLUGINACEAE**
*Glinus radiatus* (Ruiz & Pavón) Rohrbach; 15130
*Mollugo verticillata* L.; 14997, 15087

**NYCTAGINACEAE**
*Acleisanthes longiflora* A.Gray; 14870, 15079
*Boerhaavia erecta* L.; 15405
*Mirabilis albida* (Walter) Heimerl; 15035, 15352
*Nyctaginia capitata* Choisy; 15081

**OLEACEAE**
*Forestiera angustifolia* Torrey; 14906
*Fraxinus pennsylvanica* Marshall; 15091
*Menodora heterophylla* Moricand; 14943, 15523

**ONAGRACEAE**
*Calylophus berlandieri* Spach; 14900, 15530
*Gaura brachycarpa* Small; 14960, 15609
*Gaura mckelveyae* (Munz) Raven & Gregory; 14866, 15541
*Ludwigia peploides* (Kunth) Raven; 15613
*Oenothera grandis* (Britton) Smyth; 14957, 15600
*Oenothera speciosa* Nuttall; 15468, 15924
**OXALIDACEAE**
*Oxalis dillenii* Jacquin; 14925, 15467

**PAPAVERACEAE**
*Argemone sanguinea* Greene; 14867, 15165

**PASSIFLORACEAE**
*Passiflora tenuiloba* Engelmann; 15142

**PHYTOLACCACEAE**
*Rivina humilis* L.; 14965, P36370

**PLANTAGINACEAE**
*Plantago hookeriana* Fischer & Meyer; 14961, 15563,
*Plantago rhodosperma* Decaisne; 15524, 15509
*Plantago virginica* L.; 15499, 15602

**POLYGALACEAE**
*Polygala alba* Nuttall; 14974, 15536

**POLYGONACEAE**
*Polygonum pensylvanicum* L.; 15665

**PORTULACACEAE**
*Portulaca pilosa* L.; 15090
*Talinum aurantiacum* Engelmann; 15145, 15735
*Talinum parviflorum* Nuttall; 15382

**PRIMULACEAE**
**Anagallis arvensis* L.; P36475

**RANUNCULACEAE**
*Clematis drummondii* Torrey & Gray; 15010

**RHAMNACEAE**
*Colubrina texensis* (Torrey & Gray) A.Gray; 14882, 15577
*Condalia hookerii* M.C. Johnston; 14873, 15105
*Condalia spathulata* A.Gray; 15041, 15752
*Karwinskia humboldtiana* (J.A. Schultes) Zuccarini; 14875
*Ziziphus obtusifolia* (Torrey & Gray) A.Gray; 14913

**RUBIACEAE**
*Diodia teres* Walter; 15213, 15591
*Galium aparine* L.; 15498
*Galium proliferum* A.Gray; 15503, 15636
*Houstonia croftiae* Britton & Rusby; 15616
*Houstonia micrantha* (Shinners) Terrell; 15598
*Richardia tricocca* (Torrey & Gray) Standley; 15088

**RUTACEAE**
*Thamnosma texana* (A.Gray) Torrey; 15640
*Zanthoxylum fagara* (L.) Sargent; 15025

**SALICACEAE**
*Populus deltoides* Marshall; 15133
*Salix nigra* Marshall; 15612

**SAPINDACEAE**
*Sapindus saponaria* L.; 15753

**SAPOTACEAE**
*Sideroxylon celastrinum* (Kunth) Pennington; P36378

**SCROPHULARIACEAE**
*Agalinis strictifolia* (Benthen) Pennell; 14985
*Bacopa rotundifolia* (Michaux) Wettstein; 15749
*Castilleja indivisa* Engelmann; 15653
*Leucophyllum frutescens* (Berlandier) I.M. Johnston; 14939
*Nuttallanthus texanus* (Scheele) Sutton; 15169, 15486
*Veronica peregrina* L.; 15492

**SIMAROUBACEAE**
*Castela erecta* Turpin subsp. *texana* (Torrey & Gray) J. Rose; 15756, P36473
**SOLANACEAE**
*Chamaesaracha coniodes* (Moricand) Britton; 15400, 15474
*Lycium berlandieri* Dunal; 14921, 15194
*Physalis cinerascens* (Dunal) A. Hitchcock; 14932, 15102
*Solanum triquetrum* Cavanilles; 15013, 15608

**STERCULIACEAE**
*Hermannia texana* A.Gray; 14914
*Melochia tomentosa* L.; 15356

**ULMACEAE**
*Celtis laevigata* Willdenow; 15054
*Celtis pallida* Torrey; 14917, P36377
*Ulmus crassifolia* Nuttall; 15751

**URTICACEAE**
*Parietaria pensylvanica* Willdenow var. *obtusa* (Small) Shinners; 15172
*Urtica chamaedryoides* Pursh; 15482

**VERBENACEAE**
*Aloysia gratissima* (Gillies & Hooker) Troncoso; 15418
*Glandularia pumila* (Rydberg) Umber; P35307
*Glandularia quadrangulata* (Heller) Umber; 15003, 15569
*Lantana achyranthifolia* Desfontaines; 14952, 15512
*Lantana camara* L.; 14904, P35270
*Lippia graveolens* Kunth; 15157
*Phyla nodiflora* (L.) Greene; 14998, 15124
*Verbena halei* Small; 14899, 15466
*Verbena plicata* Greene; 15354

**VIOLACEAE**
*Hybanthus verticillatus* (Ortega) Baillon; 15533, 15629

**VISCACEAE**
*Phoradendron tomentosum* (DC.) A.Gray; 15040, P36368

**VITACEAE**
*Cissus incisa* Des Moulins; 14869, 15099

**ZYGOPHYLLACEAE**
*Guajacum angustifolium* Engelmann; 14950
*Tribulus terrestris L.; 15076